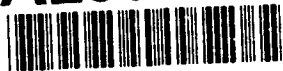


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**AIR FORCE MANPOWER, PERSONNEL,
AND TRAINING (MPT) IN SYSTEMS
ACQUISITION RESEARCH PROGRAM**

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Brooks Air Force Base, TX 78235-5000**

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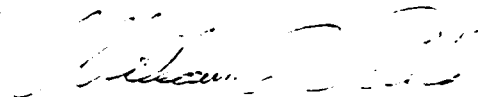
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PREFACE

The Acquisition MPT Technology research and development (R&D) program in the MPT Integration Branch is a comprehensive effort to aid System Program Office (SPO) decision makers/analysts and Major Air Command (MAJCOM) planning shops to determine the needed MPT requirements for a major weapon system and then ensure that those requirements are met during the weapon system design process. Eight research projects are being conducted to develop the tools and techniques needed. This work is part of Project 7719, Force Acquisition and Management Systems, and Project 2922, Manpower and Force Management.

I offer my special thanks to Dr Bruce Gould who, as branch senior scientist, provided much needed support and guidance for this paper and who collaborated with me on a similar effort. I would also like to thank the Acquisition MPT Technology research team for their dedicated efforts to make this research program work: Dr Barbara Sorensen, team leader and training systems expert; Capt Dave Dahn, software engineer and MPT Decision Support System project leader; Capt Bill Weaver, manpower analyst extraordinaire; and Lt Jody Guthals, data base linkage expert and operations research analyst. Finally, I want to thank Ms Stephanie Lopez, a student co-op from the University of Texas at San Antonio, who compiled the bibliography.

SUMMARY

This paper describes the extensive Manpower, Personnel, and Training (MPT) in Systems Acquisition research and development (R&D) program conducted in the MPT Integration Branch. The program is aimed at providing the analytical tools and database linkages to help decision makers and analysts ensure MPT issues are an integral early part of the acquisition and modification of major weapon systems. After a brief description of the acquisition process including past MPT studies, the requirements governing the research effort and a short history of MPT in the Air Force will be presented. Then past branch efforts will be described followed by the eight research projects that make up the current R&D program. Cooperative efforts with other government agencies, including the Army and Navy, will then be discussed. Finally, an extensive bibliography of MPT related papers and studies is included.

Air Force Manpower, Personnel, and Training (MPT) in Systems Acquisition Research Program

I. INTRODUCTION

The acquisition, or modification, of major weapon systems by the military services is a long term, extremely complicated, and very costly process. In an era of decreasing defense budgets, each system is coming under increasing scrutiny as to need, requirements, logistics support, and life cycle costs (LCCs) by both Congress and the Department of Defense (DoD). The key element in any weapon system is the human. For too long, people have been the last factor considered when developing a weapon system, even though they make up over half the LCC of a weapon system. Thus, when the weapon system has been delivered, the people have not been there or ready to operate, maintain, and support it. Many manpower, personnel, and training (MPT) issues must be considered throughout the acquisition process to ensure the weapon system is fully supportable. The human in the loop is critical to a successful weapon system. To clarify terminology, manpower refers to the number of positions needed, personnel to the types of people required and their characteristics, and training to what they need to know to do the job.

The Human Resources Directorate of the Armstrong Laboratory (AL/HR), formerly called the Air Force Human Resources Laboratory (AFHRL), in Air Force Systems Command (AFSC) is engaged in a long-term, comprehensive MPT research program. Its objective is to help System Program Offices (SPOs) and Major Air Commands (MAJCOMs) develop the most supportable weapon system at the least LCC, evaluate the MPT requirements of designs, and set MPT constraints for designs to target. Analytical tools and data base linkages are needed to accomplish these objectives as well as quantify the impact and emphasis needed for consideration of MPT issues throughout the acquisition process. The MPT Integration Branch (AL/HRMM), within the Manpower and Personnel Division (AL/HRM), is employing operations research approaches, systems analysis tools, statistical methods, and computer modeling techniques to develop these tools and make them available to decision makers, analysts, and program planners.

This paper will briefly describe the acquisition process and previous MPT studies; identify the requirements driving the MPT research program; describe the analytical models, tools, and data bases being developed through eight research and development (R&D) projects in the branch; and discuss cooperative MPT research efforts with other government agencies. Finally an extensive bibliography of MPT papers, publications, and documents is attached.

II. ACQUISITION PROCESS

Milestones

The weapon system acquisition process is composed of seven phases with six milestones (critical decision points) between them (SAS001, 1988). It covers the entire life cycle of a system, from birth to death, from initial concepts to retirement from service, including modifications. Phase I is the Pre-concept phase where mission requirements analyses are performed and a Statement of Operational Need (SON) is developed and validated by a MAJCOM. A part of this plan is to identify a supportable number of people needed to operate, maintain, and support the system. This culminates in Milestone 0 where an Acquisition Decision Memorandum (ADM) is published by the Defense Acquisition Board (DAB) for major weapon systems. Phase II is Concept Exploration where different ideas are considered in concept trade studies to meet the need and specific performance and support requirements are established. A Statement of Operational Requirements Document (SORD) is developed. This document is updated throughout the acquisition process. The MAJCOM planning personnel are still involved, but AFSC Product Division planning groups (XRs) are now involved. This culminates in Milestone I where a decision, embodied in the ADM, is made to proceed or not, based on cost and budget constraints.

Phase III is the Demonstration/Validation (DEMVAL) phase, where the selected concepts are fleshed out into actual hardware or software prototypes (SAS006). New technologies may be needed or off-the-shelf ones may be used or modified. This leads to Milestone II, where the DAB reviews the system and decides to proceed further. Cost and manpower estimates, contained in the Cost and Operational Effectiveness Analyses (COEA) report and the Manpower Estimate Report (MER), are required at this step and at Milestone III. Phase IV is the Full Scale Development (FSD) phase where the first operational test version (system prototype) is built and demonstrated, or two competing ones are built for a fly-off. Next, at Milestone III, the previous documents are updated and a decision, again via the ADM, is made whether the system should be built or not.

Phase V is the Production of the weapon system and Deployment to the operational MAJCOM. At Milestone IV, the DAB confirms that the system is on track and ready for operational use. Phase VI is usually the longest phase since this is the Operational Readiness and Support (O&S) part of a weapon system's life cycle. Some systems could be retired at the end of this phase. However, if modifications are needed, then Milestone V leads to major upgrades or enhancements, as needed. Phase VII is the Modification phase. Milestone VI is reached when the decision is made to retire the system from the inventory. Throughout each phase and at each milestone, MPT factors need to be considered and embodied in the required documents, including the SORD.

MPT LIFE CYCLE COSTS

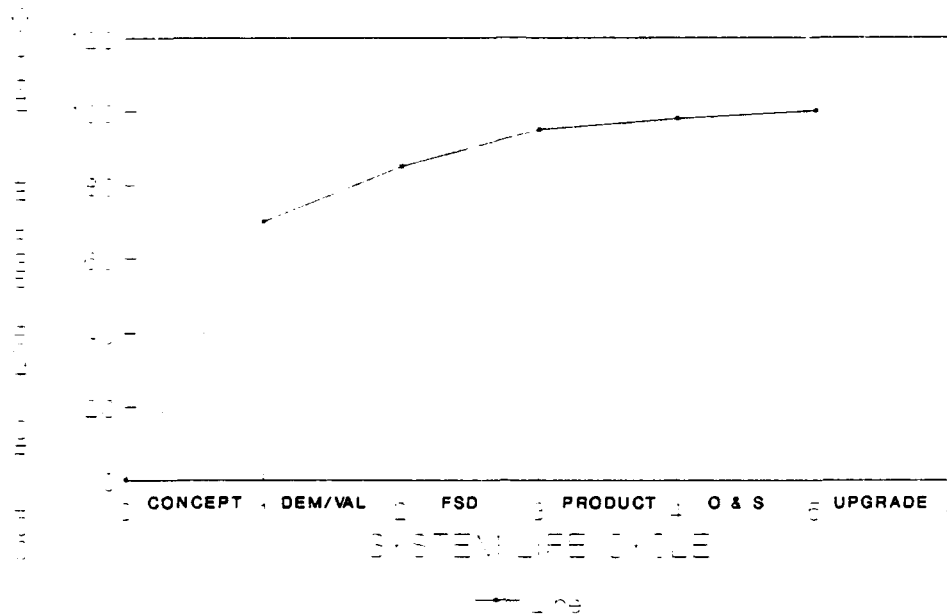


Figure 1

Life Cycle Costs

The LCCs involve not just the research, development, production, and delivery of the weapon system, but also the support and maintenance needed over its entire life (SAS004, 1990). It has been estimated that up to 85% of the total LCC of a weapon system is determined by Milestone II (as shown in Figure 1 above). The earlier MPT as well as design issues are established, the greater the potential total cost savings are. Approximately 45 to 62% of the LCCs of a weapon system can be directly attributed to MPT related issues. Thus, the human is the costliest part of a weapon system, and offers a profitable target of opportunity to reduce these costs.

Previous MPT Studies

In the late 1970s, the Air Force recognized the problem that MPT factors were not being considered properly in the acquisition process. The Air Staff asked RAND Corporation to conduct a study to determine the general roles and interactions of MPT factors (Armstrong & Moore, 1980). The next study, done by Akman Associates, Inc., examined the entire acquisition process and identified where, at each milestone, MPT issues needed to be addressed (Akman, 1983). Then a study was conducted in the mid-1980s by Booz, Allan, and Hamilton to actually develop the specific ways to insert MPT into the acquisition process. These early studies led to the Air Force's first MPT program, called RAMPARTS (Readiness Achieved through Manpower, Personnel, and

Requisite Training and Safety). Under the RAMPARTS program, attention was focused on what needed to be done in a general sense. Several documents were later developed including training programs, operational plans, and requirement documents (Akman, 1987).

Unfortunately, the RAMPARTS program did not get off the ground, due to a general lack of support and higher-level requirements. Also, the program rotated among several offices at the Air Staff and never became fully established. At this time, there was a recognition that special tools and data bases were needed to conduct the required analyses. A study commissioned by the Human Systems Division's Deputy for Development Planning (HSD/XR) identified the tools and data bases currently existing as well as holes and incompatibilities (Rossmeissl et al, 1990). It also described the characteristics a comprehensive MPT analysis system should possess. The MPT Integration Branch's research program is targeted to close these technology gaps.

III. REQUIREMENTS

Congressional and DoD

Congress in the FY87 Defense Appropriations Act required the Secretary of Defense to provide manpower and cost estimates at Milestones II and III for approval prior to entering the next phase of the acquisition process. These requirements were codified in Title 10, United States Code, Section 2434 (US Congress, 1986). The DoD formally implemented these requirements in DoD Directive 5000.53 in December 1988. The DoDD 5000 series is currently undergoing extensive revision to provide a comprehensive and coordinated direction for the entire acquisition process. DoDD 5000.53 was replaced by an expanded DoD Instruction 5000.2 in February 1991 and a new 5000.2M describing the whole Human Systems Integration (HSI) area (DoD, 1991). HSI includes the entire MPT, Human Factors Engineering, and Safety/Health Hazards arenas. Specific manpower reporting requirements in the form of a MER, development of a baseline comparable system (BCS), and required HSI supporting documentation are defined.

The three services implemented an MPTS in acquisition program in differing detail even before the DoD Directive was produced. In the Army, the program is called MANPRINT (MANpower and PerSonnel INTEgration), in the Navy it is HARDMAN (HARDware and MANpower), and in the Air Force, it is now IMPACTS (Integrated Manpower, Personnel, And Comprehensive Training and Safety) (Howell, 1989). The Army has developed a special MANPRINT regulation, AR 602-2, which requires the implementation of MANPRINT methods throughout the Army acquisition process. A recent book on the MANPRINT process provides an excellent description of the concept from a systems integration viewpoint (Booher, 1990). The Navy has formally implemented their program, but lacks an automated analysis capability.

Air Force

Presently, the Air Force is developing its own MPT regulation, AFR 800-3. The regulation establishes IMPACTS Planning Teams within the SPOs, development of MPTS-Descriptions for each major weapon system, and preparation of the needed documentation. The Air Force has a Memorandum of Agreement (MOA) signed in 1986 at the two-star level between Air Staff offices and the MAJCOMs implementing the MPT program. It established an 06-level steering committee which meets twice a year to discuss MPT acquisition issues and guide the MPT program implementation. The committee includes representation for each signer to the MOA. The MOA was recently updated in 1989 and expanded to meet the requirements of the IMPACTS program. Since 1986 the Air Force has had an MPT Directorate within the Aeronautical Systems Division (ASD/ALH) of AFSC working to instill awareness of MPT issues in all acquisition agencies in the Air Force (Mohny, 1989). They were established with 36 positions as a demonstration project within ASD. Currently, the Requirements and Organization Division in the Air Staff Directorate of Manpower and Organization (HQ USAF/MOR) is the focal point for the IMPACTS program. The Director reports directly to the Air Force Chief of Staff. The division publishes a bi-monthly IMPACTS Bulletin and are developing training programs, similar to those of Army MANPRINT, for Air Force-wide implementation.

MPTN Process

To energize research into operational concerns throughout the Air Force, AFSC has a process whereby Air Force organizations can request research using an MPT Technology Need (MPTN). During FY89, most of the MPTNs generated dealt with the acquisition process and the lack of analytical tools and integrated data base information to address MPT issues (Gentner, 1989). These MPTNs call for development of specific needed tools identified by the HSD study. The requirements driving the R&D program in the MPT Integration Branch are listed in Table 1.

IV. RESEARCH PROGRAM

Past Efforts

The Human Resources Directorate has been working in this area for some time. As AFHRL, it developed three MPT tools in the 1970s, only one of which was every operationally implemented: the Logistics Composite Model (LCOM). The other two tools, called ASSET (Acquisition of Supportable Systems Evaluation Technology) and CHRT (Coodinated Human Resources Technology), later influenced the other services (Gould, 1990). However, only recently has special research emphasis been placed on MPT in acquisition issues. Thus, in early 1987, the MPT Technology Branch (AFHRL/MOD) was created in AFHRL's Manpower and Personnel Division at Brooks AFB, Texas. A special inter-disciplinary team of researchers including industrial/organizational psychologists,

MPT RESEARCH REQUIREMENTS

Title 10, USC, Section 2434, Independent Cost Estimates: Operational Manpower Requirements. (1986)

DoD Instruction 5000.2, Defense Acquisition Management Policy and Procedures. (1991)

Air Force Regulation (AFR) 35-2, Occupational Analysis. (1982)

AFR 800-3, IMPACTS Integration Program. (in draft, 1990)

Statement of Operational Need (SON), Manpower, Personnel, Training, and Safety (MPTS) Analysis System with Integrated Data Base and Job Aids. (in draft, 1990)

Program Management Directive (PMD) 6133(12)/0603227F, Personnel, Training, and Simulation Technology. (1990)

Memorandum of Agreement (MOA), The Air Force Integrated Manpower, Personnel, and Comprehensive Training/Safety (IMPACTS) Program. (original in 1986, revised in 1989)

MPTN A89D026, Integrated MPT Data Base.

MPTN A89I028, Develop a Current Technology MPT Analysis System using Specifications from HSD's MPT Technology Study.

MPTN A89I029, Structured Approach to Identifying MPT Integration Research Issues.

MPTN A89I034, Defining the Impact of MPTS on Combat Readiness.

MPTN A89I037, Manpower Requirement Estimation Aids.

MPTN A89I038, Integrated MPT Support System Verification Model.

MPTN A89I051C, Development of MOEs for MPT in Acquisition.

MPTN A89I052C, Integrating MPT Models.

MPTN A89M046, LCOM Personnel and Training Estimation Add-ons.

MPTN A89M050C, Develop/Evaluate Manpower Models.

MPTN A88P025, Research Methods to Optimize AFS Structures for Developing Weapon Systems.

MPTN A89T011, Speeding Weapon System Training Development through Application of the CALS Concept.

MPTN 89-17T, Integration of Multiple Research Efforts into Common MPT Data Bases.

Table 1

operations research analysts, manpower experts and computer programmers was established in the branch. This was a change of direction for the division from its traditional research focus in an attempt to meet Air Force needs.

In May 1987, this new branch sponsored the first Air Force-wide MPT conference in San Antonio, Texas (Longmire & Menchaca, 1987). Under the concept "Themes for a United Direction," the conference provided a firsthand look at MPT issues from three perspectives: users, researchers, and planners. Also present were personnel from the Army and Navy. An MPT library was established within the branch to document the related issues and avoid duplication of work. It incorporates a variety of MPT-related documents and other published materials since the last MPT bibliography (Boyle, 1986).

An early 1991 reorganization of the Manpower and Personnel Division, in light of the creation of the Armstrong Laboratory and the DoD-wide Project Reliance effort, resulted in restructuring and developing the MPT Integration Branch (AL/HRMM). This branch now conducts acquisition-related MPT R&D focused in the Acquisition MPT Technology research team. The team concentrates on the early and later phases of the acquisition process, but does not directly consider design influences. Those fall within the mission area of the Logistics and Human Factors Division (AL/HRG), a sister division at Wright-Patterson AFB, whose programs will be briefly discussed later. There are eight projects currently being conducted within the MPT Integration Branch: the Specialty Structuring System (S3), MPT Functional Relationships, the MPT Decision Support System (DSS), the Weapon System Optimization Model (SYSMOD), the Training Systems for Maintenance (TRANSFORM), Logistics Composite Model (LCOM) enhancements, the Occupational Research Data Bank (ORDB), and the Weapon System Data Base Linkages (WSDBL). Each of these projects will be described to give some idea of the type of analytical work being conducted and the issues being addressed.

Specialty Structuring System

Within the Air Force the prime consideration for developing any MPT solutions involves the Air Force Specialty (AFS), or occupation, an airman works in. The assignment process, manning requirements, and the training pipeline all use this one factor. RIVET Workforce is an Air Force initiative to restructure selected enlisted maintenance AFSs to make economies across weapon systems. The idea is to move from an AFS subsystem specialization to a more weapon system specific generalist orientation. Unfortunately, this process may have been expedient but it has not provided the most efficient specialty structures. S3 is an analytical tool designed to group tasks into jobs and jobs into specialties in such a way that the most efficient specialties are developed to support a weapon system (Sorensen et al, in press). This involves developing a methodology for considering MPT tradeoffs while developing efficient specialty structures across a weapon system's complete acquisition process.

The S3 tool was developed in three phases. Phase I produced a model that outlined variables to be considered and MPT tradeoff processes in a spreadsheet format. Phase II used this model as a starting point and broadened the potential range of MPT tradeoffs, refined the processes by which the tradeoffs are considered, and produced a demonstration model for use in front-end analysis (FEA). In addition, specialty structuring issues that need to be addressed before a fully operational S3 can be developed for use during the DEMVAL and FSD phases of the acquisition process were identified. Detailed design specifications for the model were developed for the Pre-concept and Concept Exploration phases while preliminary specifications were developed for the DEMVAL and FSD phases. Phase III, the final phase of model development, is currently underway and involves the development of detailed design specifications for the DEMVAL and FSD phases and a working S3 microcomputer prototype. A process model, written in the Advanced Revelation language, is being developed for a PC. Finally, a software implementation plan, training package, and users' guide will be produced in mid-1991.

MPT Functional Relationships

To permit tradeoffs between the various MPT factors involved in the acquisition process, quantifiable formulas are required. This stream of research, to begin in late 1991, will identify and develop analytical formulas for the MPT factors. Functional relationships address the interaction of individual MPT processes. For example, when aptitude levels are lowered the same productive capacity can be obtained by increasing training, increasing the number of people and the degree of specialization, or some combinations of both. The functional relationships must be quantified to permit trade-off modeling. Such relationships range from the micro (task or subsystem) level of a weapon system to the macro (fleet) level. These relationships could range from simple calculations to extensive algorithmic logic, each specified at the appropriate level of detail. Some relationships being considered for evaluation include: (1) length of training, training burden, and aptitude; (2) retention and aptitude; (3) productive capacity, experience, and aptitude; (4) training time and training technology; (5) manpower requirements, workload, and number of specialties; (6) work efficiency, workload, and aptitude; and (7) MPT pipeline parameters. As a relationship is quantified and the resulting equation developed, it will be incorporated into other MPT models and tools being developed.

MPT Decision Support System

The MPT DSS is a new major research effort just getting started. Primary analysis goals are to validate that emerging designs meet MPT constraints imposed on contractors and to provide personnel and training planners with information and decision processes to set up efficient training and personnel pipelines before weapon system delivery. Although it will support all phases of the acquisition process, it will be used

MPT DECISION SUPPORT SYSTEM

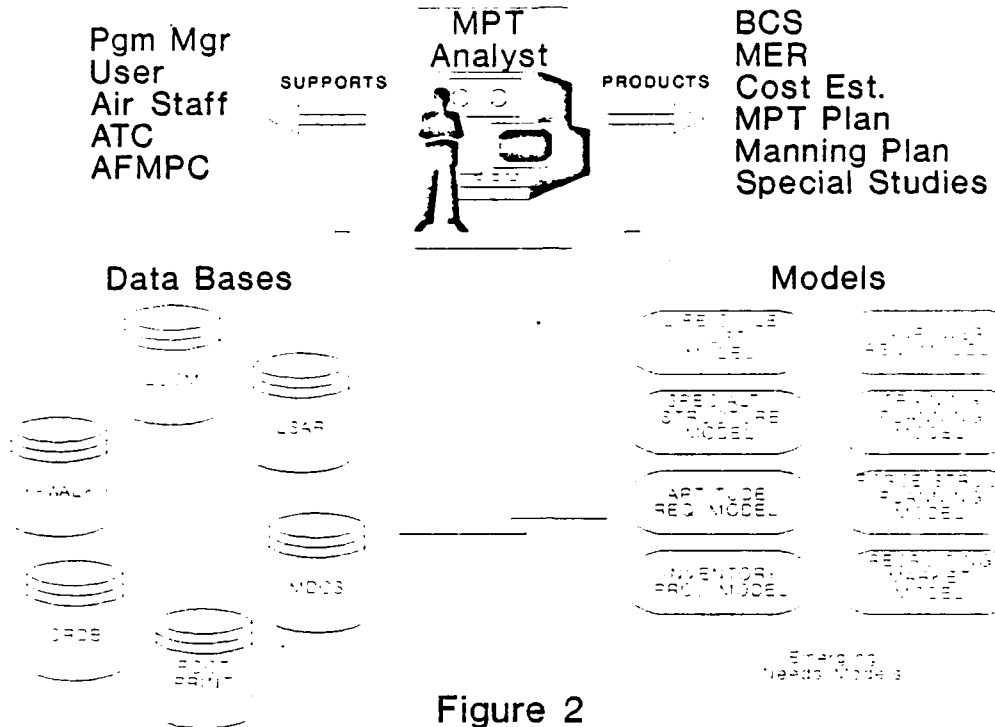


Figure 2

primarily by SPO analysts, decision makers, and design evaluators in the post-Milestone I activities. It will be based on the results of a recently completed study of MPTS factors in the system acquisition process for HSD, an FEA of a MPT modeling architecture currently underway, and an evaluation of the Army's HARDMAN III set of MPT tools. The MPT DSS is a micro-level analysis tool designed to extract data from several task-level data bases, develop a BCS architecture and library, and integrate existing or develop new analysis tools (Bergquist, 1990). Figure 2 above is a depiction of this process.

The BCS methodology is a key component of the MPT DSS and will be used in all phases of the acquisition process. It will incorporate task-level data, beginning with current weapon systems for predecessor information and replacing it with actual design data in later phases. The data base integration part of the MPT DSS will provide the needed task-level data from such sources as the Maintenance Data Collection System (MDCS), the Core Automated Maintenance System (CAMS), LCOM, ORDB, and the Logistic Support Analysis Record (LSAR). If some detailed data is not available, then Subject Matter Experts (SMEs) will be needed to supply the missing data. The analysis tool technology is core to the MPT DSS. There are seven analysis methodologies that will be incorporated or developed along with four tradeoff techniques. The methodologies used to conduct the analyses include: (1) specialty structuring, (2) manpower estimation, (3) personnel aptitude and characteristics, (4) training resources

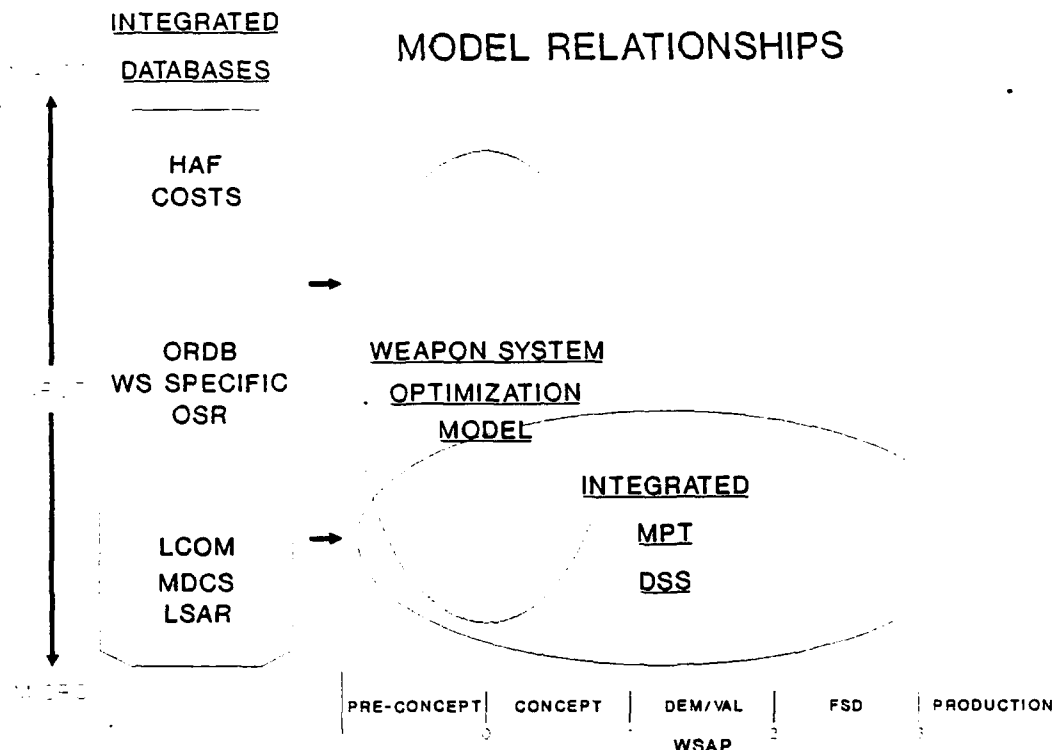


Figure 3

and requirements, (5) LCC models, (6) force structuring, and (7) inventory projection. The techniques used to conduct tradeoffs after the analyses include: (1) functional relationships, (2) measures of effectiveness (MOEs), (3) MPT pipeline considerations, and (4) specific integration capabilities.

Development of the MPT DSS will rely largely on modifying and integrating extant software, data bases, and analysis procedures. It is an advanced development process and a critical experiment to illustrate that the integration will meet users needs. Throughout its development the MPT DSS will be demonstrated on a specific weapon system. After the development, an extensive test and evaluation program will be conducted, followed by refinement and enhancements. Full documentation will be developed for the complete software system including users' manuals, maintenance documents, and design specifications. The microcomputer MPT DSS will provide an integrated data linkage and analysis tool for SPO decision makers and analysts.

Weapon System Optimization Model

SYSMOD is designed to be a new MPT constraint developing tool for use in the pre-Milestone I phases of the acquisition process. It will provide MAJCOM planning personnel and MPT Planning Team members with a model to facilitate making trades among operational system characteristics (such as reliability,

SYSMOD CONCEPTUAL APPROACH

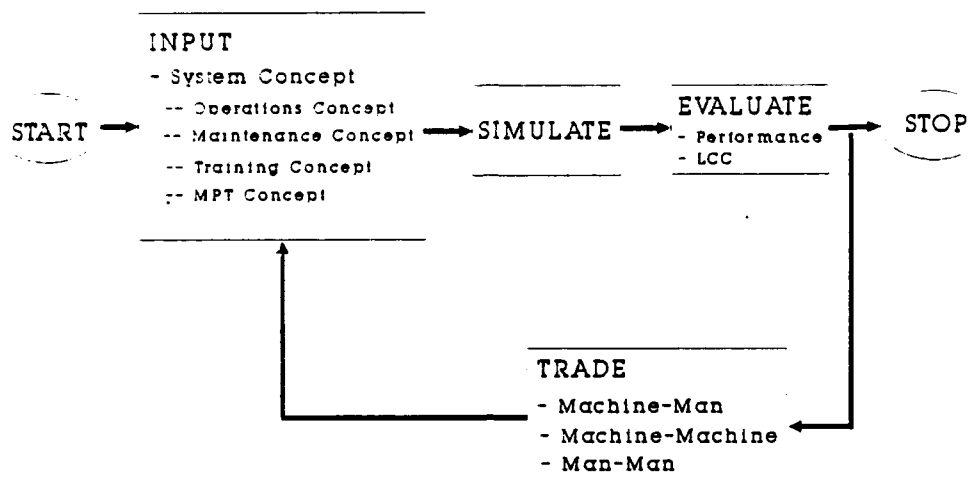


Figure 4

maintainability, supportability, survivability, etc.), maintenance and logistic concepts, and MPT factors, within specified performance and cost parameters. SYSMOD aggregates micro-level task data to conduct macro-level analyses for the early milestones of the acquisition process (Bergquist & Gould, 1991). It will share a common BCS architecture with the MPT DSS (see Figure 3 on the previous page) to allow passage of data and design criteria for later validation. A FEA is currently underway to develop the conceptual research plan as well as a demonstration model for user interaction and comment.

A proposed approach for SYSMOD is shown in Figure 4 above. The process starts with certain system concepts from a BCS database as inputs, simulates their supportability, and then evaluates the results in terms of performance and LCC criteria. If the weapon system concepts satisfy the criteria, then SYSMOD has completed the analysis and a strategy is proposed. If not, then trades are conducted on three man/machine levels and fed back to the concept stage for adjustment and refinement. The current approach emphasizes a simulation design using a queuing methodology, but some deterministic capabilities may also be needed. Once a microcomputer prototype is developed, SYSMOD will be extensively tested. It will be capable of providing the LCCs of alternate strategies for the COEA report and the SORD required as Milestone I products. SYSMOD will provide an integrated tool to develop early MPT criteria in conjunction with other "ility" requirements.

Training Systems for Maintenance

The TRANSFORM project automates the Instructional Systems Development (ISD) to LSAR interface as well as the first three steps of the ISD process. The project takes LSAR design data from constructors, extracts the needed training information, and uses it in the development of training for new emerging or modified weapon systems (Sorensen et al, 1990a). TRANSFORM was originally developed for the 3306th Training Development and Evaluation (TDES) Squadron, a part of Air Training Command at Edwards AFB CA. Prior to TRANSFORM the entire process of developing weapon system related training had been a slow, labor intensive, manual process requiring much repetitive data manipulation.

The automated ISD functions are organized in terms of five user categories: database administration, program manager, ISD analyst, quality assurance reviewer, and reference file maintainer. It includes modules that provide system security, database administration, utilities, communications, and report generation, as well as the ISD analysis core (Sorensen et al, 1990b). It uses a VAX minicomputer for LSAR data extraction and an IBM-compatible microcomputer in a local area network (LAN) for the ISD analysis. The analyst can be supported by decision support logic for selecting tasks for training, developing learning objective hierarchies, selecting instructional settings, selecting training media, identifying sequencing instructions, and identifying training equipment fidelity requirements. An audit trail records ISD analysis decisions for later review and modification. The ISD analysis is documented on automated analysis worksheets. This system, which is now operational, became the prototype for a joint service ISD/LSAR Decision Support System which has been applied at over 36 test sites across the three services (Sorensen & Park, 1990).

Logistics Composite Model

LCOM is a monte carlo, discrete-event simulation program written in SIMSCRIPT that handles multiple queues in a network arrangement (Boyle, 1990a). It determines the manpower needed to support a weapon system, based on many parameters such as operating conditions, mission scenario, number of bases, and sortie rate. It contains summarized MDCS data on components of a comparable weapon system for manpower planning. LCOM is frequently used to model aircraft maintenance activities including such resources as spare parts, support equipment, facilities, and personnel (King & Weaver, 1987). Among other things, it includes information on schedule of sortie demands, component failure rates, and a logical network of required maintenance activities. It is considered the primary manpower planning tool available today in the Air Force, but is very complicated to run on a VAX minicomputer and is very data intensive. Efforts are underway to simplify the model, add personnel and training factors to it, and develop a microcomputer version to support SPOs and XRs in manpower analysis efforts.

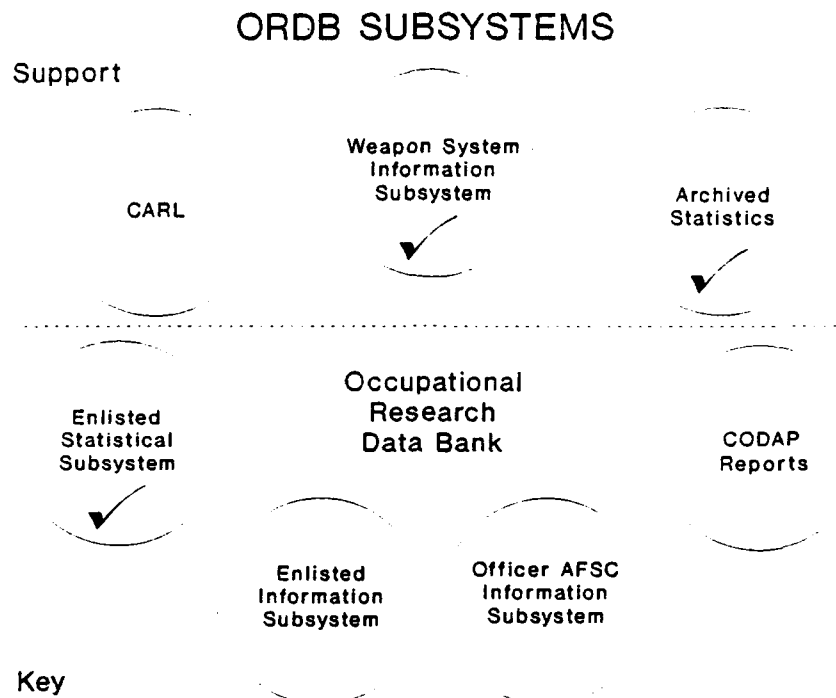


Figure 5

Occupational Research Data Bank

ORDB is an on-line occupational and demographic data repository which is undergoing significant changes to provide the needed data for MPT decision makers and analysts (Longmire & Short, 1989). Every officer and enlisted AFS in the Air Force is represented including information on the people in the occupation. It is organized into seven subsystems, four key ones and three for support: Enlisted AFSC Information Subsystem, Officer AFSC Information Subsystem, Comprehensive Occupational Data Analysis Programs (CODAP) Reports, Enlisted Statistical Subsystem, Computer Assisted Reference Locator, Archived Statistics, and Weapon System Information Subsystem (see Figure 5 above). The check mark identifies those systems which are new. It contains task performance data on each AFS from the Occupational Survey Report (OSR) file as well as demographic information on each individual airman from the Uniform Airman Record (UAR) file (Menchaca et al, 1990). The statistical analysis compability has changed from an aggregated structure to an individual record structure, thus saving much Sperry mainframe computer space and decreasing access time. The weapon system information subsystem is new and was built to provide occupational and demographic data by weapon system.

An Officer Statistical Subsystem will be completed during 1992, using the Uniform Officer Record (UOR) file. Ongoing enhancements are needed to provide the latest occupational and

TASK MATCHING

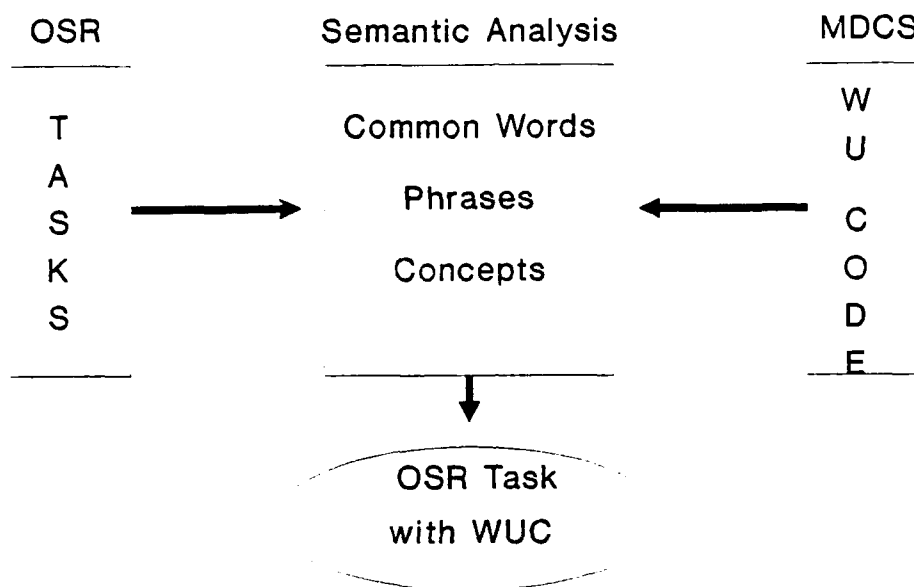


Figure 6

demographic data for decision makers in the acquisition process. Efforts are underway to place the ORDB data and analysis routines on a Write Once Read Many (WORM) drive so that it can be made available as a stand-alone user-friendly system for all users with a PC and WORM peripheral.

Weapon System Data Base Linkages

The primary problem in the MPT arena within the acquisition process is not the lack of analytical tools, because there are many of them although designed for many different purposes. Rather, the problem is the lack of integrated task-level data bases with which to drive the tools. The data bases being used (maintenance, occupational, logistic, personnel, and manpower) have differing types of data in different formats and were collected for different purposes (Short & Bergquist, 1989). The WSDBL project is mapping task statements between different data bases. Using a semantic-assisted analysis technology (SAAT), the MDCS and OSR data bases have been linked (Driskill et al, 1989). The MDCS holds data on specific maintenance activities for current weapon systems using a five-digit work unit code (WUC) structure. The tasks are identified by the action taken, the crew size, and the start and stop times of the activity. The OSR data files use specific task performance statements organized by AFS. The data includes learning difficulty, training emphasis, percent time spent performing, and percent members performing for each task.

A prototype microcomputer software package has been developed that provides a better than 85% match between these two data bases. Figure 6 on the previous page is a simplified depiction of the task matching process. The SAAT procedure first examines the data bases for common words, phrases, or concepts (WPCs). The WUCs and task statements are cross-matched based on these WPCs. The process then groups similar ideas together and replaces these WPCs with common tokens in an iterative process. Each token is evaluated within the context of its information value. This value is established by comparing the frequency with which a token occurs within a subset of the statements with its frequency of occurrence outside this subset. The next step is to link the MDCS and OSR data bases with the LSAR data structures. Also, a weapon system oriented task inventory survey process will be developed starting in late 1991 which is similar to the current AFS occupational survey.

Future Plans

As each tool and data base linkage technology is developed it will be delivered to users. The MPT Integration Branch is working closely with ASD/ALH, HSD/XR, and AF/MOR as research is conducted. As the underlying technologies become mature, they will be incorporated into developmental tools and transitioned to users as quickly as possible. The MPT Functional Relationships research effort promises to achieve fundamental insights and changes to the way the Air Force understands and conducts trade-offs between MPT factors and personnel and training pipelines. As part of its charter, the Branch will also fold in technologies developed by other branches within the Human Resources Directorate to improve and enhance its research products.

V. PROGRAM INTERACTIONS

Armstrong Laboratory

In addition to the Manpower and Personnel Division, the Logistics and Human Factors Division (AL/HRG) of the Human Resources Directorate has long conducted research on logistic and acquisition issues and originally developed LCOM, ASSET, and CHRT in the 1970s. The division now concentrates primarily on the design issues in the middle of the acquisition process. There are three projects that directly bear on the MPT in acquisition research program: the Small Unit Maintenance Manpower Analysis (SUMMA) model, the Top Down Tools for Logistics (TDSTL), and the Design Evaluation for Personnel, Training, and Human Factors (DEPTH). In addition, a Directorate-wide MPT Working Group was established to coordinate the broad based MPT acquisition-related research being conducted and to prevent duplication of efforts.

SUMMA is a microcomputer manpower analysis tool aimed at solving the maintenance AFS definition problem (Boyle, 1990b). It uses LCOM as a source of task data and as an external validity check on sortie manpower values. Through its task allocation

module (TAM), it can rearrange tasks to deal with the manpower problems encountered in aircraft sortie generation. Parts of SUMMA, which have recently been completed and given to the MPT Integration Branch, are also being incorporated into the S3 model. TDSTL, or "Toadstool," is a new effort just getting underway aimed at working out the logistics-oriented trade-off variables of practical significance to systems engineering (Miller & Boyle, 1991). These include manpower, job scope, task complexity, reliability, and "packaging" concepts. TDSTL uses an analytical queuing model similar to SUMMA's TAM in creating this trade-off technology. DEPTH is a new long-range project to create a graphics-based task analysis technology for prototyping maintenance "personnel systems" (Boyle et al, 1990). It will build on the Crew Chief man-model computer aided design (CAD) tool previously built by AL/HRG to help engineers design Human Factors/MPT feedback and hence influence designs from the inside out during DEMVAL and FSD.

Human Systems Division

HSD has undertaken developing technologies and delivering products to support the human in the Air Force. HSD is the only one of AFSC's four product divisions with this mission. HSD/XR is proactively working the MPT issues, in conjunction with the other product division XRs and MAJCOM XRs. Their previous MPTS study laid the groundwork. The MPT Integration Branch is working closely with HSD/XR, especially on the HSI Critical Process Team (CPT). This team, chaired by HSD/XR with representation from each Armstrong Laboratory directorate, is concerned with all areas of HSI in the acquisition process. Also, SYSMOD, as a pre-Milestone I planning and requirements setting tool, will directly aid XRs throughout the Air Force.

Air Force

The primary proponent of MPT in the Air Force is ASD/ALH. They are also a user, but not a maintainer, of the research projects. Their liaison with product division and MAJCOM XRs has been pervasive. Unfortunately, the lack of general officer support is still a problem. The Air Staff focal point for IMPACTS and MPTS has been a moving target, but now resides in the AF/MO Directorate, along with productivity and Total Quality Management (TQM) programs. With strong general officer support, the MPT program will be able to effect change.

Army and Navy

In the early 1980s, the Navy used part of the ASSET and CHRT tools, developed by the Air Force, to develop a paper-and-pencil analysis capability called HARDMAN. This is also the name of their MPT program and remains the same today as it was ten years ago. The Army modified and automated the HARDMAN tools and called it MIST (Man Integrated Systems Technology). An enhanced version of MIST, called HARDMAN II, is being developed. Meanwhile, the Army Research Institute (ARI) has begun a three-

phase development of a brand new set of MPT analysis tools called HARDMAN III (Kaplan, 1991). Phase I of HARDMAN III consists of six separate tools: SPARC, which sets performance criteria; M-CON, T-CON, and P-CON, which set MPT constraints; and MAN-SEVAL and PER-SEVAL, which evaluate the designs. Phase II models include HOS V, for below task-level modeling; MANCAP II, for unit level manpower availability; FORCE, for service-wide requirements; and AMCOS, for costing. Phase III completes the effort with SCAD and ICARUS, which conduct MPT and design trade-offs; and T-SEVAL, for training evaluation. Unfortunately, only the first set of tools has been fully funded for development.

During the past two years, researchers at ARI and AL/HRM have been keeping each other informed on their respective MPT projects. With the recent completion of the prototype Phase I HARDMAN III tools, and the start of major Air Force MPT development, plans have been made to share data and analysis techniques to ensure compatibility and avoid duplication. The Air Force is preparing to evaluate the HARDMAN III tools for modification and applicability to the Air Force. ARI personnel have agreed to provide consultation to AL/HR. Efforts are also being started to consider a joint service project to examine deficiencies in current MPT analysis capabilities DoD-wide and expand on funding opportunities.

However, there are major differences in mission orientation that would preclude direct application of Army HARDMAN III software to Air Force needs and before a full set of joint service analysis tools can be developed. The Air Force makes more use of SMEs to modify and build new baseline comparison detailed task level data, the AFS structure is a core component of any Air Force model, emphasis is placed on enlisted maintenance, and new weapon systems are less likely to have a single predecessor system. The Army uses existing empirical data, lacks a training evaluation module in HARDMAN III, and emphasizes operator support. The Navy does not currently have an ongoing MPT in acquisition research program. Despite these differences, a great deal of mutual cooperation and sharing of information is underway.

VI. SUMMARY

To properly insert MPT factors into the acquisition process as required by Congressional law and DoD directive, much analytical research is being undertaken. The Air Force's IMPACTS program is a means of inserting MPT factors into the acquisition of major weapon systems. The Human Resources Directorate of the Armstrong Laboratory is developing the tools, techniques, and data base linkages to assist MAJCOM planning personnel and SPO analysts to meet these requirements. A comprehensive, coordinated R&D program is underway within the MPT Integration Branch consisting of eight projects: Specialty Structuring System, MPT Functional Relationships, MPT Decision Support System, Weapon System Optimization Model, Training Systems For

Maintenance, Logistic Composite Model, Occupational Research Data Bank, and Weapon System Data Base Linkages. These projects will give Air Force decision makers, analysts, and planning personnel the capability to accomplish their job of providing the best weapon system for the least LCC. Finally, close cooperation with the Army and Navy will avoid duplication and enhance compatibility of MPT tool and model development.

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